This year's winners

The winners of the *ICIS Chemical Business* 2007 Innovation Awards have developed products that offer real potential to the chemical industry – and the world

JOHN BAKER/LONDON

AT LAST, we can reveal the winners of the ICIS Innovation Awards 2007, sponsored for the fourth year running by Dow Corning.

The awards have again proved that innovation is alive and well in the chemical industry, and that it comes in many forms. And, as always, they emphasize that there is plenty of scope for successful innovation, in the form of new or enhanced products or processes, or new service offerings to customers.

This year's winners (see box and subsequent pages) encompass: a new route to polycarbonate (PC); an important and versatile engineering thermoplastic that avoids the use of phosgene; a novel treatment for leather that keeps the wearer cool in the sun; an integrated process for converting crude palm oil into nutritional specialties, as well as biodiesel; and a tool for specifying hydraulic fluids that reduce energy use, and thus carbon dioxide (CO_2) emissions in power systems.

Asahi Kasei Chemicals' development was unanimously hailed as the best process innovation. It is a classic example of re-engineering an entire process to make it safer and less environmentally damaging. This new process, with new starting materials "delivered value for the company as well as society and was a clear winner," commented judge Michael Droescher.

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THE WINNERS THIS YEAR

Winners exhibit "green" values by cutting toxic emissions, reducing energy costs, and extracting more value from biofuel feedstocks

BEST PROCESS INNOVATION
ASAHI KASEI CHEMICALS (JAPAN)
Novel, phosgene-free route to polycarbonate

BEST PRODUCT INNOVATION
TFL LEDERTECHNIK (GERMANY)
A solar-reflective leather to keep the wearer cool

BEST ENVIRONMENTAL INNOVATION
ROHMAX OIL ADDITIVES (PART OF EVONIK, FORMERLY DEGUSSA) (GERMANY/US)
A novel approach to saving energy through hydraulic fluid design

BEST INNOVATION BY AN SME
CAROTECH (MALAYSIA)
Integrated process for extraction of phytonutrients and biodiesel from crude palm oil

In the case of TFL Ledertechnik's *Cool System* for leather, there was, as Droescher commented, a "wow!" factor – demonstrating that even in a mature sector such as leather processing, there can be startling, unexpected innovation. Judge Dirk Carrez added that TFL had demonstrated an in-depth knowledge of the properties of a natural material to come up with innovative dyes and coatings that worked with the properties of the leather to deliver the desired effect. And, added Carrez, the innovation is very close to the consumer and offers a nice example with which to explain the benefits of chemicals to the public.

The SME category was won by Malaysian company Carotech, with its integrated process to take virgin crude palm oil and extract specialty chemicals such as tocotrienol, mixed carotenes and phytosterols, before using the bulk of the raw material to manufacture biodiesel and glycerin. The extracts are used in dietary supplements and functional foods and drinks.

The development, commented Mark Humphries, took a natural product and delivered a range of value-added products, some going into quite advanced health care applications. The innovation was also hailed as a good example of the move to develop biorefineries, which are high on the agenda in Europe and the US.

The winner in the best environmental innovation category – RohMax Oil Additives' mathematical model – was hailed as a good example of what can be done by taking a systematic approach to a problem and then developing a customer proposition. The model allows RohMax to calculate the efficiencies that can be achieved in hydraulic power systems by specifying the correct additives to give high viscosity and stability to mechanical sheer. The customer benefits from energy savings, despite the higher cost of the hydraulic fluids.

As Humphries pointed out, "the gains and efficiencies can be quite significant… [it shows] innovation can be driven by different approaches and on a broad level." The judges also thought the approach could have much wider usage, in areas such as automotive power systems, for example, helping increase fuel efficiencies and reduce CO_2 emissions.

The four winning entries are profiled in more depth on the following pages. ■

For further information, go to **www.icis.com/awards** or email: **john.baker@icis.com**

THE JUDGES

Once again, ICIS assembled a panel of eminent judges to choose the winners...

MARK HUMPHRIES
is a partner in the engineering physics group and a member of PA Technology's management group

DR GREGG ZANK
is vice president, chief technology officer and executive director of science and technology at awards sponsor Dow Corning

DR DIRK CARREZ
is director of public policy at EuropaBio and head of its industrial biotechnology council

PROF DR MICHAEL DROESCHER
is senior vice president, corporate innovation, at Evonik Industries (formerly Degussa)

PROFESSOR PAUL O'BRIEN
is professor of inorganic materials chemistry, the chemistry department and the materials science center, University of Manchester, UK

Incubating innovation

A unique approach to stimulating research and development allows Dow Corning to create a fertile breeding ground for success

JOHN BAKER/LONDON

INNOVATION IS a key strategic priority at Dow Corning. To ensure a regular flow of sizeable, commercially viable projects, the company has embraced the concept of the business and technology incubator, explains Marie Eckstein, vice president and general manager of the company's Advanced Technologies and Ventures business unit.

The $4.4bn (€3.1bn) turnover company looks on innovation as a core competency and views it under three categories: revitalization of current businesses; the acceleration of growth in high-potential businesses; and the incubation and creation of future businesses.

The business and technology incubator (BTI) approach "is somewhat unique" to Dow Corning, says Eckstein. "The aim is to incubate significant new businesses for the future... We don't want incremental innovation but are looking for step changes," she adds.

The approach involves a tricky balancing act: running the incubator separately from the existing strategic business units in Dow Corning, while operating in ways that are still connected to the marketplace.

Eckstein describes this task as "insulating and connecting" the BTI at the same time, and adds: "We have worked out ways to do this, so we understand the customer needs, but at the same time, we take new ways to approach the market."

The incubator starts with regular reviews of the mega-trends in the world today and analyzes the opportunities and challenges these throw up against Dow Corning's core capabilities and those it could develop.

"We are looking at issues such as the environment and energy, information management and quality of life, and assessing what we can bring to the table and where to put our innovation dollars," says Eckstein.

Projects for the incubator essentially move through three phases. First is the discovery phase, consisting of idea generation linked to the mega-trends. Second is the exploration stage, where researchers "dive deep" to see what is feasible, and third is the shaping phase, where Dow Corning builds the capabilities needed to put the ideas into practice and transfer them either into existing or new business units.

> **"We understand customer needs, but at the same time, we take new ways to approach the market"**
>
> **Marie Eckstein**, vice president and general manager, Dow Corning's Advanced Technologies and Ventures

It is important during these stages that the people, processes and ideas that are different are protected until they are ready to be developed commercially, or dropped. The result is ideally new technology or business platforms aligned with discontinuities and needs in major markets and/or the utilisation of novel silicon-based materials and processes that diversify Dow Corning's technology base.

Eckstein gives two examples of products that are now emerging from the incubator, some five to six years after it was first established.

One is a range of sugar siloxanes, in which polar sugar molecules – saccharides – are linked to nonpolar silicones to make the resulting molecules water-soluble and agglomerative. The combination offers potentially interesting and useful properties.

For example, liquid silicones can be converted to solids such as powders, waxes and gums. Dow Corning's emerging technology team for personal care has evaluated the materials for use in hair conditioners, skin creams and antiwrinkle fabric care formulations.

The second is a breakthrough grade of silicon that increases the availability of silicon suitable for making photovoltaic solar cells.

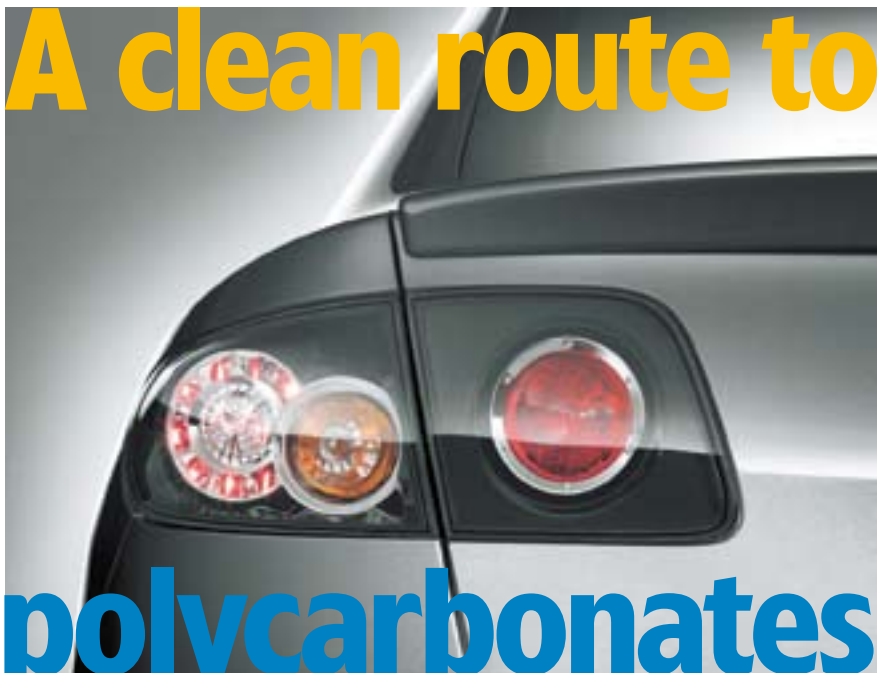
The solar-grade silicon (SoG) is derived from metallurgical grade silicon and thus offers the solar cell industry a blending material for use alongside high-purity polysilicon. This gives solar cell makers the ability to extend their supply of high-demand polycrystalline silicon.

The SoG silicon blended with polycrystalline silicon creates a material that still exhibits good solar cell performance. As such, says Dow Corning, it offers a means of growth for the solar industry. The company is now commercializing SoG as *PV 1101*, made at its new plant in Santos Dumont, Brazil, through its Solar Solutions Group.

Projects in the incubator generally have a five-year time frame and are not constrained by the need to make immediate paybacks. Funding is scrutinized and allocated through the company's Growth Council, and progress is assessed by operational and steering committees, which include incubator and business unit personnel, to give the connectivity to the marketplace.

Although important, the incubator is "just one more way Dow Corning is innovating to meet its customers' needs" says Eckstein. She stresses, too, that it is not just materials that Dow Corning is looking to innovate, but also processes and business models, making it an important tool for building Dow Corning's technology platforms and ensuring that there is a balance of major and incremental innovations in the overall pipeline. ■

A clean route to polycarbonates



After 30 years of development, a company has come up with a way to manufacture this clear plastic without producing highly toxic by-products

EMMA CHYNOWETH/LONDON

ASAHI KASEI Chemicals must be running out of wall space as a result of all the awards it has received in recognition of its development of a phosgene-free route to polycarbonates (PCs). Let's hope it has space for the ICIS Process Innovation Award, too!

The new process, the development of which began in 1977, uses three raw materials – ethylene oxide (EO), carbon dioxide (CO_2) and bisphenol A (BPA) – which are converted to PC and high-purity ethylene glycol (EG), without any waste or waste water. The technology is based on recycle-type reactive distillation methods to produce the intermediate monomer, and a new gravity-based non-agitating unit equipped with vertical glides for the polymerization.

A phosgene-free route to PCs has been a long time coming, with a number of producers seeking to overcome the inherent problems related to the process. Not only are phosgene and the other raw material, methylene chloride, highly toxic, but the process generates large quantities of wastewater and PC with chlorine impurities.

Shinsuke Fukuoka, who, along with Kyosuke Komiya and Shigenori Konno is credited with the development, notes that there were significant barriers to develop the phosgene-free route. These included developing an economical process technology to produce the safe monomer diphenyl carbonate (DPC) with sufficient purity, and the polymerization technology to remove by-produced phenol from the ultrahigh-viscosity molten prepolymer.

But Asahi cracked both problems. The first step of the process sees DPC produced from phenol and dimethyl carbonate – both recycled within the process. The reaction and distillation steps are carried out simultaneously in the same column. The breakthrough in polymerization came in the design of a gravity-based, nonagitated vertical reactor, fitted with guides. This gives relatively stable and efficient production.

After bench work began in 1986 and pilot-scale development in 1988, the process was commercialized in 2002 with a 65,000 tonne/year facility built by Chimei-Asahi in Taiwan. It is now used at a second, 75,000 tonne/year facility of that joint venture, and has been licensed to Kazan Orgsyntex in Russia. Three companies have licensed it, with start-ups expected from 2008–2010.

Asahi Kasei has a policy to license the technology openly because of the contribution it makes to society – it expects 25% of total world production of the polymer to be based on its process within the next few years. PC, the largest-volume engineering plastic, with a market of 3m tonnes/year, is expected to grow at 10%/year.

Asahi says a plant based on the process costs around half the traditional cost of phosgene-based units. It adds that production costs are also lower because the raw materials are cheaper, more products are recycled within the process and the resultant PC is purer.

Fukuoka says: "Although the polycarbonate resin market was small – about 30,000 tonnes/year when we started the basic research – the market was expected to grow because the resin has excellent properties such as good transparency and impact resistance." He was eager to develop an innovative process for producing PC to replace the phosgene process that was the only commercialized route.

Asahi Kasei employs about 2,000 people and invests around $444m (€316m), or 3.2% of net sales in 2006, in research. Fukuoka adds that from its history the company has possessed "a DNA which encourages researchers and engineers to challenge and innovate in extremely difficult subjects." He adds that from the early 1980s the R&D administration of the company took a keen interest in developing environmentally friendly technologies. "We intended to replace this phosgene process, which was not environmentally friendly, with one that was."

And that process has not stopped. Fukuoka notes that work is continuing to further refine and develop the technology – especially to improve productivity and energy consumption. He adds that the process can be adopted for polycondensation polymerization reactions in general. Developments for producing polyethylene terephthalate (PET) and polytrimethylene terephthalate (PTT) have already been completed. And a number of polyester production patents have been filed globally. ■

» For more information on Asahi Kasei, visit **www.asahi-kasei.co.jp**

Look and stay cool in leather

A chance meeting on a business trip eight years ago led to the innovation by TFL of solar reflective leather, which dazzled the judges and won the ICIS Innovation Award this year for best product

EMMA CHYNOWETH/LONDON

IT WAS several thousand feet above the US on a flight that Jurgen Christner, head of research applications for leather chemicals business TFL Ledertechnik, found himself sitting next to inventor Gerd Hugo of IPS Innovations. Hugo had already developed a solar reflective technology that has subsequently been used in a number of fields, including construction.

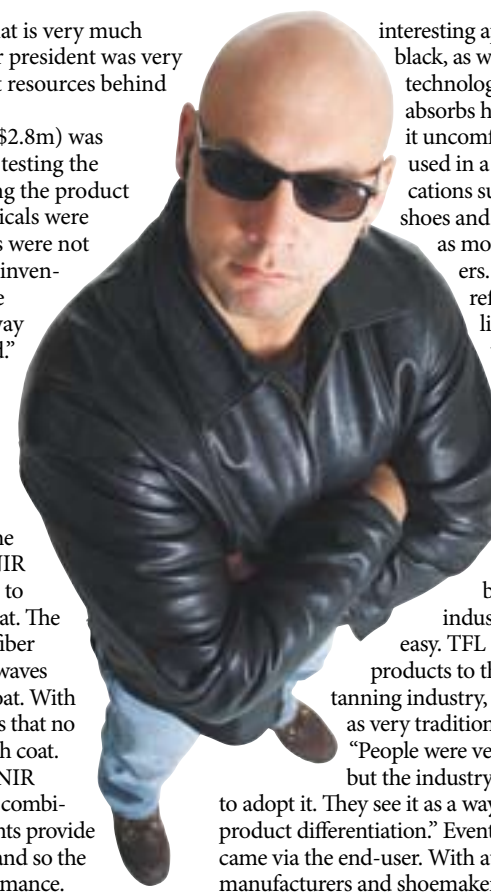
When Christner returned to his office he wondered how the technology could be applied in his leather products.

He knew uncoated natural leather possesses very good solar reflective properties as its structure is made up of a fibrous collagen network. However, this property is lost when the leather is coated with a pigment finish. The pigments absorb most of the near-infrared (NIR) waves and heat builds up within the finish coat and material when it is exposed to sunlight. This is a problem particularly for dark-colored leather.

Christner wondered if the technology could have an application in car seats, and he contacted Hugo. The two exchanged ideas and tested a number of pigment samples. With positive results, Christner approached his president. He points out that TFL has a management culture that is very much open to innovation. "Our president was very excited and agreed to put resources behind the project."

In total, around €2m ($2.8m) was invested in selecting and testing the right pigments, and taking the product to market. No new chemicals were involved, as the pigments were not new products. "The new invention is the way we put the chemicals together, the way they are applied and used."

The patented technology comprises what the firm calls *Cool* dyes, to color the leather, and *Cool* NIR transparent pigments, which are applied as a finish coat. The pigments do not absorb NIR waves, so they allow them to pass through the finish coat. The leather's natural collagen fiber network reflects the NIR waves back through the finish coat. With no absorption, the result is that no heat is built up in the finish coat. The dyes also show good NIR reflection – only the right combination of dyes and pigments provide the optimum reflectance and so the best solar reflective performance.



Christner says the technology means that black leather can be 20–25% cooler than without the finish. Since the light energy is reflected in the NIR, less heat energy is formed and the leather remains cooler. The temperature difference between standard and *Cool* leather increases with the duration and intensity of sun exposure. In extreme cases, the temperature difference can be up to 20°C (36°F), according to TFL.

The company has developed the know-how across a wide range of colors, but the most interesting application is black, as without the *Cool* technology the material absorbs heat, making it uncomfortable when used in a range of applications such as car seats, shoes and garments, such as motorcycle leathers. "Our black reflects light like [it was] white," says Christner. The technology can be used across other textiles and substrates.

Getting acceptance by the leather industry was not easy. TFL supplies products to the leather and tanning industry, both described as very traditional by Christner. "People were very impressed, but the industry was slow to adopt it. They see it as a way for further product differentiation." Eventually, success came via the end-user. With automotive manufacturers and shoemakers specifying the technology, commercialization began in 2003.

Christner says it has been particularly successful when used in car seats of convertibles, steering wheels and traditional shoes. He is also looking to the international fashion arena, where he hopes designers will use it. "You can wear leather in summer and not get hot. It's a cool idea," he says. ■

» For more information on TFL and its products, go to **www.tfl.com**

Flowing green

RohMax Oil Additives has proven the green credentials of its products, winning the ICIS Innovation Awards 2007 environmental category

EMMA CHYNOWETH/LONDON

AT FIRST glance, you might wonder what hydraulic fluids ever did for the environment. Conventional wisdom believed efficient fluid power systems were borne out of good design and state-of-the-art pumps and engines, but RohMax Oil Additives, part of Evonik's Specialty Acrylics business, has successfully challenged that idea.

It has developed a verifiable mathematical model that demonstrates that efficiency improvements of between 10 and 25% can be gained from the use of fluids that combine a high viscosity index and a high stability to mechanical shear. The work, which began in 2002, is the winner of ICIS Innovation Awards 2007, in the environmental category.

The development is particularly useful for hydraulically driven mobile equipment, which includes construction and agricultural machinery. Here, the improvement translates directly into a greater than 10% reduction in the amount of fuel consumed to do a job, and consequently cuts emissions of carbon dioxide (CO_2) and particulates, among others.

Robert Woodruff, director of innovation management at RohMax, notes that the work began in 2002 with a proposal from Doug Placek, who at the time was product manager for hydraulic fluids, to look at business opportunities in the expanding market for multigrade hydraulic fluids. The company supplies various additives used to boost the performance of such oils.

Making a fundamental analysis of the application of hydraulic fluids in a pump, Christian Neveu, marketing manager in the company's Paris office, developed a set of mathematical models showing the fluid flow and energy within a hydraulic pump circuit. He could see waste in the system, and that by using fluids with a higher viscosity index, the pump could achieve more without increasing fuel consumption.

Placek says that hydraulic fluid additives serve a number of purposes including extending the life of the product or protecting against wear and corrosion.

About 15% of the total market comprises premium products that have been developed for special applications, such as use in colder or hotter temperatures. Woodruff says the cost of the additive is insignificant if the customer looks at the total benefits, including fuel saving, productivity and emissions reduction. Multigrade hydraulic fluids sell at around a 50% premium to monograde.

The key to success and innovation of the RohMax approach was demonstrating the value to customers. "Early on we identified the advantages using theoretical models... Then we had to verify them in real hydraulic equipment. We are fluid formulation experts, but not hardware experts," says Mike Zink, business segment manager for hydraulic fluids.

A field test based on a well-known brand of excavator showed a greater than 15% efficiency improvement using the premium hydraulic fluid containing the high viscosity index. "We were surprised ourselves by the magnitude of improvement, and realized that economic and environmental benefits would be of value to lubricant manufacturers, equipment builders, and operators alike.

The problem for RohMax was driving its work through several commercial layers – through blenders and lubricant makers, and through distributors – to get the value to the end user. It set up a program to look at a wide variety of pumps and to work with original equipment manufacturers (OEMs).

After five years, Woodruff says the work is finally starting to pay off, with OEMs now specifying use of these improved fluids. In addition, a number of leading oil marketers around the world are launching hydraulic fluids that meet the Maximum Efficiency Hydraulic Fluids (MEHF) performance level.

Placek adds that hydraulic fluids continue to face new challenges. A trend toward the design and use of smaller hydraulic pumps – operating at higher pressures without power loss, or with improved speed – places greater stress on the fluids used.

RohMax has a strong focus on fuel economy and the need for further refinements. It is also working with a research consortium on robotics and hybrid vehicles. "We will certainly try to exploit our knowledge and develop new fluids as a result," says Woodruff.

He adds that getting the ICIS award is an honor and a pleasure – especially rewarding for the global effort the company has invested in the project. Around 20 people, including Steven Herzog in Horsham, Pennsylvania, US, and Klaus Hedrich, Michael Alibert and Roland Schweder, in Darmstadt, Germany, have worked hard to see the program through. ■

» For more information on RohMax products, visit **www.rohmax.com**

Palm oil offers up prizes

An integrated approach to extracting specialty chemicals, as well as making biodiesel from palm oil, has proved rewarding for Carotech

EMMA CHYNOWETH/LONDON

MALAYSIA'S CAROTECH has won the ICIS Innovation Award for small and medium-sized enterprises (SMEs), with its integrated process for the extraction and concentration of a range of phytonutrients and production of biodiesel from virgin crude palm oil.

The technology, coupled with strong marketing, has made Carotech the largest global producer of palm phytonutrient tocotrienol – described as a "super-vitamin E" – and a major biodiesel player.

Carotech now produces about 40,000 tonnes/year of biodiesel at its Chemor, Ipoh plant, in Malaysia, which has seen an investment of around ringgit (M$) 120m ($35m, €25m). It is also scheduled to bring a 120,000 tonne/year state-of-the art biodiesel plant onstream by the end of 2007. This unit, located at Lumut Port, Malaysia, will cost M$155m.

Carotech started to look at various technologies for the extraction of palm phytonutrients and production of biodiesel (methyl ester) in the late 1980s. At that time, its parent company, generic drug producer Hovid, launched a dietary supplement line of products based on imported vitamin E and beta-carotene. CEO David Ho saw the potential to develop commercial extraction of phytonutrients from the large volumes of virgin palm oil processed in Malaysia. Palm oil contains high levels of tocotrienol, a unique form of vitamin E, and mixed carotenes.

In 1992, the company was granted a US patent for an integrated process for the extraction of phytonutrients and production of methyl ester from virgin crude palm oil. Weng-Hoong Leong joined the company in 1993 as a process engineer – its first employee – and was given responsibility for commercializing the technology.

"We went into production in 1995 with a small capacity of 1,500 tonnes/year of crude palm oil. At that time, we were the only plant in the world commercially to extract tocotrienols, mixed carotene and phytosterols from palm oil," says Leong, now the company's vice president. In 1996, due to the high demand for the products in the US, Carotech set up a worldwide sales and marketing office in New Jersey, US.

He notes that when the company first started, lack of funds and seed capital was one of the main problems. "Plantation companies did not want to invest in Carotech, thinking that the technology was not viable. We went ahead with the financial support of Hovid and we proved the critics wrong. It is, in a sense, a vindication for Carotech, culminating in our IPO in April 2005."

The company encountered a number of other hurdles en route to commercialization.

Running the first molecular distillation plant in Malaysia required overcoming and mastering a number of production issues, such as achieving ultra-high vacuums in a large-scale commercial plant. "Molecular distillation is a unique distillation process that involves the generation of extremely high vacuum. With such high vacuum, we are able to distill and concentrate heat-sensitive phytonutrients, such as tocotrienol and mixed carotene, at temperatures below 100°C [212°F]."

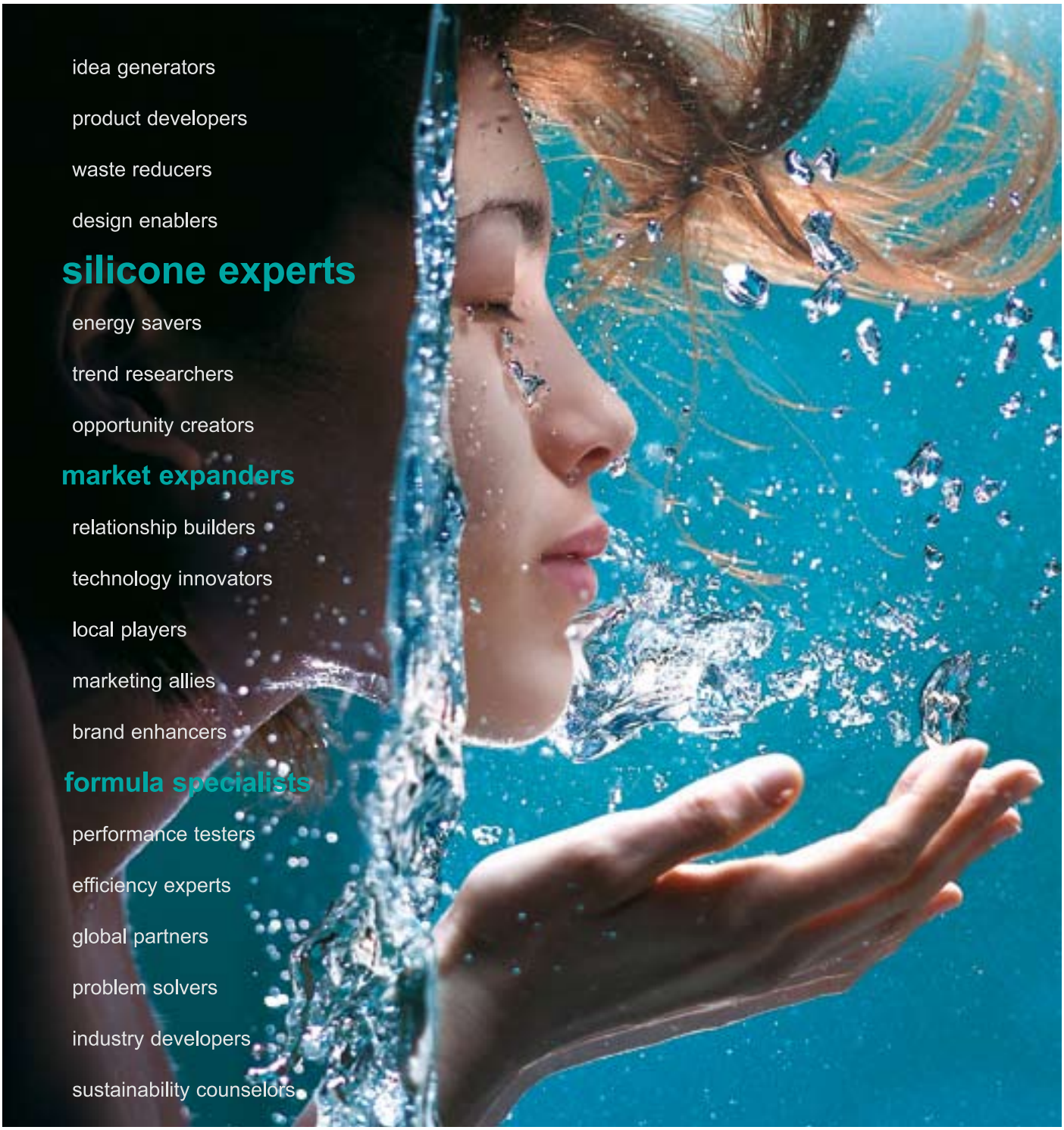
Carotech also faced a lack of awareness of tocotrienols among consumers. "It was an uphill battle to convince dietary supplement companies and, most importantly, regular consumers that tocotrienol is a form of natural vitamin E, as opposed to the well-known tocopherols, and that it has unique health benefits not shown by the tocopherols.

"We embarked on a costly national PR campaign in the US to educate consumers about this new form of vitamin," says Leong. The benefits of the product include cholesterol reduction and reversal of arterial blockage in patients suffering from carotid stenosis. The products are also 40–60 times more potent as an antioxidant, inhibiting both oestrogen-negative and oestrogen-positive breast cancer cells.

On the phytonutrients side, Carotech is currently trying to make the product more stable, especially for topical cosmetic applications. "We are also looking into various derivatives of the phytonutrients, either to make them more effective or efficacious," says Leong.

For biodiesel, the company is aiming to produce palm biodiesel with a low cold filter plugging point through the use of additives as well as physical processes. ■

» For more information about Carotech's innovations, visit **www.carotech.net**



Which Dow Corning do you need today?

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